(12) UK Patent Application (19) GB (11) 2 114 745 A

(21) Application No **8303865**
(22) Date of filing **11 Feb 1983**
(30) Priority data
(31) **8204217**
(32) **12 Feb 1982**
(33) **United Kingdom (GB)**
(43) Application published
24 Aug 1983
(51) INT CL[3]
H04R 11/00 G01F 23/28
G01N 11/16 29/04
(52) Domestic classification
G1G 6 7D 7T ED PL PN
(56) Documents cited
GB A 2079940
GB A 2078955
GB 1349255
GB 1125364
GB 0861436
(58) Field of search
G1G
G5J
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(54) **Electromagnetically driven tuning fork for determining fluid properties**

(57) An instrument for sensing a characteristic of a fluid by its effect on a vibrating tuning fork exposed in the fluid comprises a non-magnetic wall (4) forming in use a boundary to the space occupied by the fluid; a W-shaped magnetic yoke the three legs (1,2) of which extend through the wall in use into contact with the liquid with the base part of the W on the outside of the wall; the end of the central leg (2) being bifurcated to form tuning fork tines (3) each spaced from, and facing in its direction of vibration, a respective adjacent one of the outer legs; and a coil (5) associated with the base part of the W and arranged to be energized with an oscillating electrical current whereby periodic magnetic flux (6) is produced in the yoke to cause the tines to be vibrated as a result of the periodic magnetic attraction between each tine and the adjacent outer leg. A piezoelectric crystal detector (7) is connected to the base of the yoke to sense oscillation of the tuning fork. Associated circuitry is connected to the coil (5) and detector (7) to derive the density, viscosity, or the presence or absence of particular fluids from the resonant frequency of vibration or the attentuation in the vibration of the tuning fork.

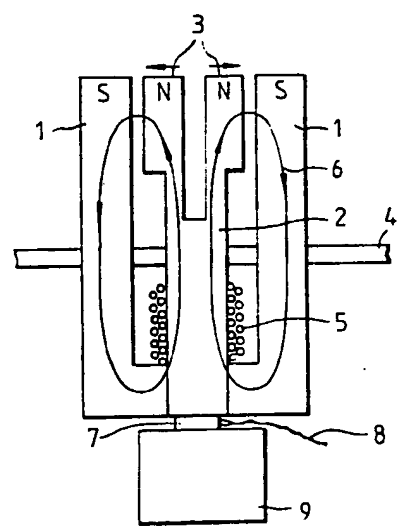

Fig.1

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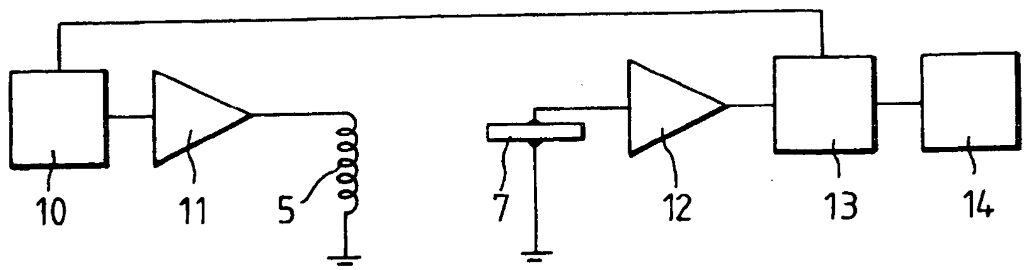

Fig. 3.

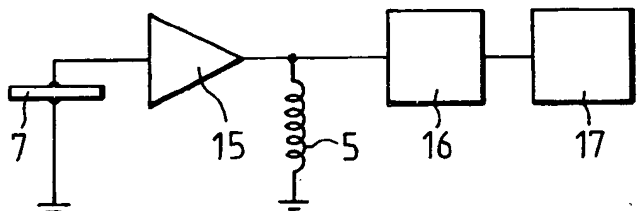

Fig. 4.

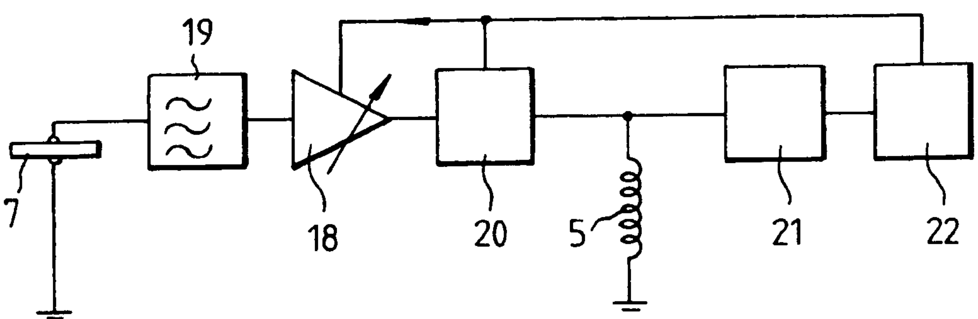

Fig. 5

part of a container for the fluid. During assembly the base part of the yoke may be welded up after insertion of the legs through the wall, or the wall may be assembled in pieces between the legs and welded up.

A coil 5 is wound on the root of the central leg and develops in the yoke a magnetic flux 6. The flux induces opposite poles at the end of each pole piece and at the end of the adjacent tuning fork tine respectively so that the two are attracted. When the coil is energised with an oscillating current, the periodic attraction causes the vibration of the tines.

A piezoelectric crystal detector 7, from which an output is taken through leads 8, is interposed between the base of the yoke and a counter-weight 9.

Figure 3 illustrates the application previously referred to for measuring the density of a fluid, particularly a liquid, by determining the resonant frequency of the tuning fork exposed in contact with the fluid. The drive coil 5 is energized by a frequency sweep generator 10 via an amplifier 11. The output of the crystal detector 7 is fed via an amplifier 12 to a frequency measurer 13 from which the necessary calculation and display is derived in a unit 14.

Figure 4 illustrates the alternative arrangement for measuring density, in which the electrical output from the crystal detector 7 is fed through a positive gain amplifier 15 to energize the drive coil 5 so that automatic resonance is obtained, the resonant frequency being recognised by a frequency measurer 16 which feeds a calculation and display unit 17.

Figure 5 shows the use of the instrument for determining the viscosity of a fluid, particularly a liquid. Thus the automatic feedback circuit of Figure 4 is modified by substituting a variable gain amplifier 18, for the positive gain amplifier 15 optionally with the interposition of a filter 19. The signal amplitude is measured by the unit 20. The resonant frequency is again measured by a unit 21 and the gain necessary to maintain oscillation is calculated and displayed by the unit 22.

Any of the illustrated circuits could be used when the instrument is adapted for use as a level sensor. As previously mentioned, it is only necessary for the calculation and display unit to discriminate between the resonant frequency or gain, which represents attenuation of the vibrating tuning fork, when the tines are immersed in different fluids, particularly liquid and air.

Claims

1. An instrument for sensing a characteristic of a fluid by its effect on a vibrating tuning fork exposed in the fluid, the instrument comprising a non-magnetic wall forming in use a boundary to the space occupied by the fluid; a W-shaped magnetic yoke the three legs of which extend through the wall in use into contact with the liquid with the base part of the W on the outside of the wall; the end of the central leg being bifurcated to form tuning fork tines each spaced from, and facing in its direction of vibration, a respective adjacent one of the outer legs; and a coil associated with the base part of the W and arranged to be energised with an oscillating electrical current whereby a periodic magnetic flux is produced in the yoke to cause the tines to be vibrated as a result of the periodic magnetic attraction between each tine and the adjacent outer leg.

2. An instrument according to claim 1, in which the coil is wound on one of the legs of the yoke.

3. An instrument according to claim 1 or claim 2, in which a detector is fitted to the yoke and is arranged to be responsive to the frequency of vibration of the tuning fork tines.

4. An instrument according to claim 3, in which the detector is a piezoelectric crystal detector fitted to the base of the yoke.

5. A fluid density measuring instrument according to claim 3 or claim 4, wherein the coil is energized by a frequency sweep generator and means are coupled to the detector for determining the peak response, corresponding to the resonant frequency of the tuning fork.

6. A fluid density measuring instrument according to claim 3 or claim 4, wherein means are provided for feeding an electrical output from the detector back through a positive gain amplifier to energize the coil, so that automatic resonance is obtained, and means are provided for determining the resonant frequency.

7. A fluid viscosity measuring instrument according to claim 3 or claim 4, wherein means are provided for sensing the energy requirement to maintain the tuning fork oscillating resonantly.

8. An instrument according to claim 7, wherein means are provided for feeding an electrical output from the detector back through a variable gain amplifier to energize the coil, and means are provided for deriving the viscosity from the gain necessary for maintaining oscillation of the tuning fork.

9. A level sensing instrument according to claim 3 or claim 4, wherein means are provided for discriminating between the resonant frequency or attenuation of the vibrating tuning fork when the tines are immersed in different fluids.

10. An instrument substantially as described with reference to any one of the modifications illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained